REMARKS

This Communications is provided to comply with the Decision, mailed March 14, 2008, to merge Reissue Application No. 10/621,637 ("Reissue") and Reexamination Proceeding Control No. 90/006,209 ("Reexamination"). Specifically, this Communication is to comply with Part II, paragraph 5 of the Decision, wherein an appropriate housekeeping amendment is required, placing the same amendments in both proceedings.

As an initial matter, Applicants' representative wishes to thank Mr. Eric Keasel for the courtesy of his time and expertise extended to representative's colleague, Atty. Jeanne Tanner, during a telephone call on April 10th, concerning the mechanics of harmonizing the claims in the Reissue and the Reexamination. Applicants' Representative has made a good faith attempt to comply with the rules and believes that this Communication provides the required amendments to make the claims the same in each file (identical amendments to be placed in all files) pursuant to MPEP 2285, Section IV and in compliance with 37 CFR 1.121(i) and 37 CFR 1.273.

I. Status of the Claims

A listing of amended claims (a "Harmonized Claim Set") for the merged Reissue Application No. 10/621,637 ("Reissue") and for Reexamination Proceeding Control No. 90/006,209 ("Reexamination") is presented on pages 2-32. The Harmonized Claim Set provides a set of identical claims for each of the above-referenced files.

Only claims that were earlier presented in the Reissue and the Reexamination are presented in this Harmonized Claim Set. Claims 1-67 and 70-127 are pending. Claims 1-65 correspond to the claims of the issued Patent (US 5,650,054). Claims 65-67 and 70-77 correspond to claims previously added to the Reissue. (Claims 68 and 69 are listed as

cancelled, because claims 68 and 69 were cancelled in the Reexamination and Applicants' representative believes that claim numbers associated with cancelled claims may not be reused.) Claims 78-127 correspond to claims either amended or added in the Reexamination. In some instances, it was necessary to change the claim numbering, including dependency numbering, to reflect the numbering of the Harmonized Claim Set.

Harmonized Claim Set provided on pages 2-32

The parenthetical status indicators provided in the Harmonized Claim Set provided on pages 2-32 herein are based on the status of the Harmonized Claim Set as against the most recent prior Reissue claim set.

In this paragraph, Applicants specifically point out what is changed with respect to each claim in the Harmonized Claim Set provided on pages 2-32 that is being amended. Claims 68 and 69 are cancelled and rewritten as new claims 76 and 77, respectively. Claims 70 and 71 are amended to change their dependency from claim 69 (now cancelled and rewritten as claim 77) to claim 77.

Harmonized Claim Set provided in Attachment A

Attachment A includes the Harmonized Claim Set with parenthetical status indicators based on the status of the Harmonized Claim Set as against the most recent prior Reexamination claim set. With the exception of the parenthetical status indicators, the Harmonized Claim Set as provided on pages 2-32 and the Harmonized Claim set as provided in Attachment A are identical.

In this paragraph, Applicants specifically point out what is changed with respect to each claim in Attachment A that is being amended. Claims 1 and 52 were previously amended during the Reexamination proceeding. By this amendment, claims 1 and 52 are amended to remove the amendments presented during the Reexamination proceeding and return claims 1 and 52 to the original, as-issued claim language. Claims 66 and 67 have

been amended to replace previously presented Reexamination claims 66 and 67 with claims 66 and 67 as previously presented in the Reissue, respectively.

A table cross-referencing the Harmonized Claim Set with the claims as previously presented in the Reissue and the Reexamination is provided for the convenience of the Examiner.

Harmonized Claim Set	Comments
Claims 1-65	Identical to Claims 1-65 of Reissue.
Claims 66-67	Identical to Claims 66-67 of Reissue.
Claims 68-69	Cancelled in Reissue (to align numbering of merged listing with claim numbering of Reexamination) and presented now as new claims 76 and 77, respectively.
Claims 70-75	Identical to Claims 70-75, respectively, of Reissue (except for renumbering of dependency due to cancellation of claims 68-69).
Claims 76-77	Identical to Claims 68-69 previously presented in Reissue (except for renumbering)
Claims 78-127	Identical to Claims 1-34 and 52-67 of Reexamination (except for renumbering), which were previously amended in the Reexamination to differ from the issued Patent claims. Note: claims 35-51 of the Reexamination were unamended and therefore are now presented as identically number claims 35-51 in the Harmonized Claim Set.

Applicants respectfully request examination of the claims.

Applicants' representative invites to the Examiner to call the undersigned attorney should the prosecution of this merged Reissue and Reexamination Proceeding be facilitated by such a call.

Applicants believe that they do not owe excess claim fees. Applicants have already paid for all of the claims in the respective Reissue and Reexamination proceedings. However, if it is deemed that fees are due, the Commissioner is hereby authorized to charge any additional fees to Deposit Account No. 19-0733.

Respectfully submitted,
Shen et al.

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By: 

Peter D. McDermott (Reg. No. 29,411)
Attorney for Applicants
BANNER & WITCOFF, LTD.
28 State Street, 28th Floor
Boston, MA 02109
Phone: (617) 720-9600
Fax: (617) 720-9601

ATTACHMENT A

HARMONIZED CLAIM SET

(with parenthetical status indicators relating to the most recent prior Reexamination claims)

1. (Twice Amended) An electrochemical gas sensor for quantitative measurement of a gas in a ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material; whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

2. (Original) The electrochemical gas sensor as defined in claim 1, wherein said water vapor containing means contains a volume of water and an antifreeze additive.

3. (Original) The electrochemical gas sensor as defined in claim 1, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area that is smaller than the surface area of the surface of the counter electrode that is exposed to said

water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode exposed to said water vapor to the surface of said sensing electrode exposed to the ambient atmosphere.

4. (Original) The electrochemical gas sensor as defined in claim 3, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

5. (Original) The electrochemical gas sensor as defined in claim 1, wherein the first protonic conductive electrolyte membrane has opposing surfaces, each of said opposing surfaces being in contact with one of the sensing and counter electrodes, wherein at least one of the opposing surfaces of said first protonic conductive electrolyte membrane in contact with one of the sensing and counter electrodes is substantially nonplanar.

6. (Original) The electrochemical gas sensor as defined in claim 1, wherein at least one of the sensing and counter electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

7. (Original) The electrochemical gas sensor as defined in claim 6, wherein the film is substantially composed of a noble metal.

8. (Original) The electrochemical gas sensor as defined in claim 7, wherein the noble metal is platinum.

9. (Original) The electrochemical gas sensor as defined in claim 1, wherein the first

protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

10. (Original) The electrochemical gas sensor as defined in claim 1, wherein the first protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

11. (Original) The electrochemical gas sensor as defined in claim 1, wherein the proton conductor material for said at least one of the sensing and counter electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

12. (Original) The electrochemical gas sensor as defined in claim 1, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of platinum.

13. (Original) The electrochemical gas sensor as defined in claim 1, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of Ru oxide.

14. (Original) The electrochemical gas sensor as defined in claim 1, wherein the electrochemical gas sensor further comprises:

first and second pump electrodes comprised of an electrical conducting material permeable to water vapor, separate from said sensing and counter electrodes, and situated on opposite sides of and in contact with said first protonic conductive electrolyte

membrane, said second pump electrode being situated on the same side of said first protonic conductive membrane as the counter electrode and having a surface thereon exposed to the water vapor in said means for exposing a surface of said counter electrode to said water vapor; and

means for applying a DC power across the first protonic conductive electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across the first protonic conductive electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

15. (Original) The electrochemical gas sensor of claim 14, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of carbon.

16. (Original) The electrochemical gas sensor as defined in claim 14, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of noble metals.

17. (Original) The electrochemical gas sensor as defined in claim 14, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of conductive hydrated metal oxides.

18. (Original) The electrochemical gas sensor as defined in claim 14, wherein at least one of the first and second pump electrodes is comprised of a film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

19. (Original) The electrochemical gas sensor as defined in claim 14, wherein the electrical conducting material of said first and second pump electrodes is a proton-

electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

20. (Original) The electrochemical gas sensor as defined in claim 19, wherein the proton conductor material for both the first and second pump electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

21. (Original) The electrochemical gas sensor as defined in claim 19, wherein one of the first and second electrical conductor materials for the first pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the first pump electrode is 1 to 50 wt % of platinum.

22. (Original) The electrochemical gas sensor as defined in claim 19, wherein one of the first and second electrical conductor materials for the second pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the second pump electrode is 1 to 50 wt % of Ru oxide.

23. (Original) The electrochemical gas sensor as defined in claim 1, wherein the electrochemical gas sensor further comprises:

a second protonic conductive electrolyte membrane permeable to water vapor;

first and second pump electrodes permeable to water vapor and comprised of an electron conductive material, and being separate from said sensing and counter electrodes and situated on opposite sides of and in contact with said second protonic conductive electrolyte membrane, said means for exposing a surface of said counter electrode to said water vapor exposing a surface of said second pump electrode to said water vapor, and said first pump electrode having a surface exposed to the ambient atmosphere; and

means for applying a DC power across said second protonic electrolyte membrane, said first and second pump electrodes having in electrical connection

therebetween said means for applying DC power across said second protonic electrolyte membrane;
whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

24. (Original) The electrochemical gas sensor as defined in claim 23, wherein the second protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

25. (Original) The electrochemical gas sensor as defined in claim 23, wherein the second protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

26. (Original) The electrochemical gas sensor as defined in claim 23, wherein the surface area of the surface of said first pump electrode that is exposed to the ambient atmosphere is smaller than the surface area of the surface of the second pump electrode that is exposed to said water vapor, whereby the second protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said second pump electrode that is exposed to said water vapor to the surface of said first pump electrode that is exposed to the ambient atmosphere.

27. (Original) The electrochemical gas sensor as defined in claim 26, wherein the surface area of the surface of the second pump electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

28. (Original) The electrochemical gas sensor as defined in claim 1, further comprising:

means for applying a DC pulse power source across the first protonic conductive membrane, said sensing and counter electrodes having in electrical connection therebetween said means for applying DC pulse power across the first protonic conductive membrane; and

switch means for alternating the connection between the sensing and counter electrodes from the electrical measurement means to the DC pulse power means; whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic when said switch means connects said electrical measurement means to the sensing and counter electrodes; and

whereby said DC pulse power means moves the gas away from a side of the gas sensor where the counter electrode is placed when said switch means connects said DC pulse power means to the sensing and counter electrodes.

29. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is CO.

30. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is NO_x.

31. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is hydrogen.

32. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is H_2S.

33. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is H_2O vapor.

34. (Original) The electrochemical gas sensor as defined in claim 1, wherein the gas is alcohol vapor.

35. (Original) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated in between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

a second protonic conductive electrolyte membrane permeable to water vapor;

first and second pump electrodes permeable to water vapor and comprised of an electrical conductive material, and being separate from said sensing and counter electrodes and situated on opposite sides of and in contact with said second protonic conductive electrolyte membrane;

means, containing a volume of water vapor, for exposing a surface of said second pump electrode to said water vapor, and said first pump electrode having a surface exposed to the ambient atmosphere, said second pump electrode being separated from said counter electrode by said means for exposing a surface of said second pump electrode to said water vapor, and said counter electrode having a surface exposed to said water vapor by said means for exposing a surface of said second pump electrode to said water vapor;

means for electrical measurement in electrical communication with said sensing electrode and said counter electrode; and

means for applying a DC power across said second protonic electrolyte membrane in electrical contact with said first and second pump electrodes;
whereby the gas is transported away from the counter electrode when the DC power means applies a DC power across said second protonic electrolyte membrane; and whereby, in a positive ambient concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

36. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of said first and second protonic conductive electrolyte membranes is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

37. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the first and second protonic conductive electrolyte membranes is a hydrated metal oxide protonic conductor electrolyte membrane.

38. (Original) The electrochemical gas sensor as defined in claim 35, wherein the surface of said first pump electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the second pump electrode that is exposed to said water vapor, and wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, a positive pressure of said water vapor exists from the surface of said counter electrode that is exposed to said water vapor to the surface of said sensing electrode that is exposed to the ambient atmosphere, the second protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said second pump electrode that is exposed to said water vapor to the surface of said first pump electrode that is exposed to the ambient atmosphere.

39. (Original) The electrochemical gas sensor as defined in claim 38, wherein the surface area of each of the surfaces of the second pump and counter electrodes that are exposed to said water vapor by said means for exposing a surface of said second pump electrode to said water vapor are each separated from said means for exposing a surface of said second pump electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

40. (Original) The electrochemical gas sensor as defined in claim 35, wherein said means for exposing a surface of said second pump electrode to said water vapor further contains an antifreeze additive.

41. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the surfaces of said first protonic conductive electrolyte membrane in contact with one of the sensing and counter electrodes is substantially nonplanar, and wherein at least one of the surfaces of said second protonic conductive electrolyte membrane in contact with one of the first and second pump electrodes is substantially nonplanar.

42. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the sensing, counter, first pump, and second pump electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

43. (Original) The electrochemical gas sensor as defined in claim 42, wherein the film is substantially composed of a noble metal.

44. (Original) The electrochemical gas sensor as defined in claim 43, wherein the noble metal is platinum.

45. (Original) The electrochemical gas sensor as defined in claim 35, wherein the at least one of the sensing, counter, first pump, and second pump electrodes is substantially comprised of proton conductive material.

46. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the first and second protonic conductive electrolyte membranes is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

47. (Original) The electrochemical gas sensor as defined in claim 35, wherein at least one of the first and second protonic conductive electrolyte membranes is a hydrated metal oxide protonic conductive electrolyte membrane.

48. (Original) The electrochemical gas sensor as defined in claim 35, wherein the electrical conducting material of at least one of said sensing, counter, first pump, and second pump electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

49. (Original) The electrochemical gas sensor as defined in claim 48, wherein the proton conductor material for said at least one of the sensing, counter, first pump, and second pump electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

50. (Original) The electrochemical gas sensor as defined in claim 48, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump, and second pump electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump and second pump electrodes is about 1-50 wt % of platinum.

51. (Original) The electrochemical gas sensor as defined in claim 48, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump, and second pump electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, first pump, and second pump electrodes is about 1-50 wt % of Ru oxide.

52. (Twice Amended) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and being exposed to the ambient atmosphere;

a reference electrode permeable to water vapor and comprised of an electrical conducting material;

a counter electrode permeable to water vapor and comprised of an electrical conducting material and being separate from both said sensing and reference electrodes, and being exposed to the ambient atmosphere;

a protonic conductive electrolyte membrane permeable to water vapor, having top and bottom sides, said bottom side of said protonic conductive membrane being in contact with the counter electrode, and the top side of said protonic conductive membrane being in contact with the sensing and reference electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode; and

means for electrical measurement in electrical contact between the sensing electrode and the counter electrode, wherein the electrical conducting material of at least one of said sensing, counter, and reference electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

53. (Original) The electrochemical gas sensor as defined in claim 52, further comprising:

means for applying a DC power across said protonic electrolyte membrane in electrical contact between the sensing electrode and said counter electrode, whereby the gas is transported away from the counter electrode when the DC power means applies a DC power across said protonic electrolyte membrane.

54. (Original) The electrochemical gas sensor as defined in claim 52, wherein said means for exposing a surface of said counter electrode to said water vapor further contains an antifreeze additive.

55. (Original) The electrochemical gas sensor as defined in claim 52, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode that is exposed to said water vapor to the surface of said sensing electrode that is exposed to the ambient atmosphere.

56. (Original) The electrochemical gas sensor as defined in claim 55, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

57. (Original) The electrochemical gas sensor as defined in claim 52, wherein at least one of the surfaces of said protonic conductive electrolyte membrane in contact with one of

the sensing, counter, and reference electrodes is substantially nonplanar.

58. (Original) The electrochemical gas sensor as defined in claim 52, wherein at least one of the sensing, counter, and reference electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

59. (Original) The electrochemical gas sensor as defined in claim 58, wherein the film is substantially composed of a noble metal.

60. (Original) The electrochemical gas sensor as defined in claim 59, wherein the noble metal is platinum.

61. (Original) The electrochemical gas sensor as defined in claim 52, wherein the protonic conductive electrolyte membrane is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

62. (Original) The electrochemical gas sensor as defined in claim 52, wherein the protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

63. (Original) The electrochemical gas sensor as defined in claim 52, wherein the proton conductor material for said at least one of the sensing, counter, and reference electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

64. (Original) The electrochemical gas sensor as defined in claim 52, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first

and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of platinum.

65. (Original) The electrochemical gas sensor as defined in claim 52, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of Ru oxide.

Claim 66. (Twice Amended) A two-electrode electrochemical gas sensor for measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode and the counter electrode being the only two electrodes in contact with the first protonic conductive electrolyte membrane and the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material; whereby, in a positive ambient atmosphere concentration of

said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 67. (Amended) An electrochemical gas sensor for measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material; whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 68. (Cancelled)

Claim 69. (Cancelled)

Claim 70. (New) The electrochemical gas sensor of claim 77 in which the sensing electrode and the counter electrode are the only two electrodes in contact with the first protonic conductive electrolyte membrane.

Claim 71. (New) The electrochemical gas sensor of claim 77 in which the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode.

Claim 72. (New) The electrochemical gas sensor of claim 70 in which the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode.

Claim 73. (New) A non-biased electrochemical gas sensor for measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic in the absence of any biasing voltage.

Claim 74. (New) The non-biased electrochemical gas sensor of claim 73 in which the sensing electrode and the counter electrode are the only two electrodes in contact with the first protonic conductive electrolyte membrane.

Claim 75. (New) The non-biased electrochemical gas sensor of claim 73 in which the sensing electrode reacts with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode.

Claim 76. (New) A two-electrode electrochemical gas sensor for measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode and the counter electrode being the only two electrodes in contact with the first protonic conductive electrolyte membrane, and the sensing electrode reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode in the absence of an applied voltage to the sensing electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of

said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material; whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 77. (New) An electrochemical gas sensor for measurement of a gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode and the counter electrode being on opposite sides of the first protonic conductive electrolyte membrane;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic.

Claim 78. (New) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere at room temperature comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode being capable of reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes, said means for electrical measurement being capable of detecting changes in said electrical characteristic in a positive ambient atmosphere concentration of said gas;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Claim 79. (New) The electrochemical gas sensor as defined in claim 78, wherein said water vapor containing means contains a volume of water and an antifreeze additive.

Claim 80. (New) The electrochemical gas sensor as defined in claim 78, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area that is smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode exposed to said water vapor to the surface of said sensing electrode exposed to the ambient atmosphere.

Claim 81. (New) The electrochemical gas sensor as defined in claim 80, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

Claim 82. (New) The electrochemical gas sensor as defined in claim 78, wherein the first protonic conductive electrolyte membrane has opposing surfaces, each of said opposing surfaces being in contact with one of the sensing and counter electrodes, wherein at least one of the opposing surfaces of said first protonic conductive electrolyte membrane in contact with one of the sensing and counter electrodes is substantially nonplanar.

Claim 83. (New) The electrochemical gas sensor as defined in claim 78, wherein at least one of the sensing and counter electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

Claim 84. (New) The electrochemical gas sensor as defined in claim 83, wherein the film is substantially composed of a noble metal.

Claim 85. (New) The electrochemical gas sensor as defined in claim 84, wherein the noble metal is platinum.

Claim 86. (New) The electrochemical gas sensor as defined in claim 78, wherein the first protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

Claim 87. (New) The electrochemical gas sensor as defined in claim 78, wherein the first protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

Claim 88. (New) The electrochemical gas sensor as defined in claim 78, wherein the proton conductor material for said at least one of the sensing and counter electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

Claim 89. (New) The electrochemical gas sensor as defined in claim 78, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of platinum.

Claim 90. (New) The electrochemical gas sensor as defined in claim 78, wherein one of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing and counter electrodes is about 1-50 wt % of Ru oxide.

Claim 91. (New) The electrochemical gas sensor as defined in claim 78, wherein the electrochemical gas sensor further comprises:

first and second pump electrodes comprised of an electrical conducting material permeable to water vapor, separate from said sensing and counter electrodes, and situated on opposite sides of and in contact with said first protonic conductive electrolyte membrane, said second pump electrode being situated on the same side of said first protonic conductive membrane as the counter electrode and having a surface thereon exposed to the water vapor in said means for exposing a surface of said counter electrode

to said water vapor; and means for applying a DC power across the first protonic conductive electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across the first protonic conductive electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

Claim 92. (New) The electrochemical gas sensor of claim 91, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of carbon.

Claim 93. (New) The electrochemical gas sensor as defined in claim 91, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of noble metals.

Claim 94. (New) The electrochemical gas sensor as defined in claim 91, wherein the electrical conducting material of the first and second pump electrodes is substantially composed of conductive hydrated metal oxides.

Claim 95. (New) The electrochemical gas sensor as defined in claim 91, wherein at least one of the first and second pump electrodes is comprised of a film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

Claim 96. (New) The electrochemical gas sensor as defined in claim 91, wherein the electrical conducting material of said first and second pump electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material.

Claim 97. (New) The electrochemical gas sensor as defined in claim 96, wherein the

proton conductor material for both the first and second pump electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

Claim 98. (New) The electrochemical gas sensor as defined in claim 96, wherein one of the first and second electrical conductor materials for the first pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the first pump electrode is 1 to 50 wt % of platinum.

Claim 99. (New) The electrochemical gas sensor as defined in claim 96, wherein one of the first and second electrical conductor materials for the second pump electrode is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for the second pump electrode is 1 to 50 wt % of Ru oxide.

Claim 100. (New) The electrochemical gas sensor as defined in claim 78, wherein the electrochemical gas sensor further comprises:

a second protonic conductive electrolyte membrane permeable to water vapor;

first and second pump electrodes permeable to water vapor and comprised of an electron conductive material, and being separate from said sensing and counter electrodes and situated on opposite sides of and in contact with said second protonic conductive electrolyte membrane, said means for exposing a surface of said counter electrode to said water vapor exposing a surface of said second pump electrode to said water vapor, and said first pump electrode having a surface exposed to the ambient atmosphere; and

means for applying a DC power across said second protonic electrolyte membrane, said first and second pump electrodes having in electrical connection therebetween said means for applying DC power across said second protonic electrolyte membrane;

whereby the gas is transported away from the counter electrode when the DC power means applies a DC power to the first and second pump electrodes.

Claim 101. (New) The electrochemical gas sensor as defined in claim 100, wherein the second protonic conductive electrolyte membrane is substantially composed of a solid, perfluorinated, ion-exchange polymer.

Claim 102. (New) The electrochemical gas sensor as defined in claim 100, wherein the second protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

Claim 103. (New) The electrochemical gas sensor as defined in claim 100, wherein the surface area of the surface of said first pump electrode that is exposed to the ambient atmosphere is smaller than the surface area of the surface of the second pump electrode that is exposed to said water vapor, whereby the second protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said second pump electrode that is exposed to said water vapor to the surface of said first pump electrode that is exposed to the ambient atmosphere.

Claim 104. (New) The electrochemical gas sensor as defined in claim 103, wherein the surface area of the surface of the second pump electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

Claim 105. (New) The electrochemical gas sensor as defined in claim 78, further comprising:

means for applying a DC pulse power source across the first protonic conductive membrane, said sensing and counter electrodes having in electrical connection

therebetween said means for applying DC pulse power across the first protonic conductive membrane; and

switch means for alternating the connection between the sensing and counter electrodes from the electrical measurement means to the DC pulse power means; whereby, in a positive ambient atmosphere concentration of said gas, said electrical measurement means detects changes in said electrical characteristic when said switch means connects said electrical measurement means to the sensing and counter electrodes; and

whereby said DC pulse power means moves the gas away from a side of the gas sensor where the counter electrode is placed when said switch means connects said DC pulse power means to the sensing and counter electrodes.

Claim 106. (New) The electrochemical gas sensor as defined in claim 78, wherein the gas is CO.

Claim 107. (New) The electrochemical gas sensor as defined in claim 78, wherein the gas is NO_x.

Claim 108. (New) The electrochemical gas sensor as defined in claim 78, wherein the gas is hydrogen.

Claim 109. The electrochemical gas sensor as defined in claim 78, wherein the gas is H_2S.

Claim 110. (New) The electrochemical gas sensor as defined in claim 78, wherein the gas is H_2O vapor.

Claim 111. (New) The electrochemical gas sensor as defined in claim 78, wherein the gas is alcohol vapor.

Claim 112. (New) An electrochemical gas sensor for quantitative measurement of a gas in an ambient atmosphere at room temperature comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and being exposed to the ambient atmosphere;

a reference electrode permeable to water vapor and comprised of an electrical conducting material;

a counter electrode permeable to water vapor and comprised of an electrical conducting material and being separate from both said sensing and reference electrodes, and being exposed to the ambient atmosphere;

a protonic conductive electrolyte membrane permeable to water vapor, having top and bottom sides, said bottom side of said protonic conductive membrane being in contact with the counter electrode, and the top side of said protonic conductive membrane being in contact with the sensing and reference electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, the sensing electrode being capable of reacting with the gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode; and

means for electrical measurement in electrical contact between the sensing electrode and the counter electrode, wherein the electrical conducting material of at least one of said sensing, counter, and reference electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient concentration of said gas, said electrical measurement means is capable of detecting changes in said electrical characteristic.

Claim 113. (New) The electrochemical gas sensor as defined in claim 112, further comprising:

means for applying a DC power across said protonic electrolyte membrane in electrical contact between the sensing electrode and said counter electrode, whereby the gas is transported away from the counter electrode when the DC power means applies a DC power across said protonic electrolyte membrane.

Claim 114. (New) The electrochemical gas sensor as defined in claim 112, wherein said means for exposing a surface of said counter electrode to said water vapor further contains an antifreeze additive.

Claim 115. (New) The electrochemical gas sensor as defined in claim 112, wherein the surface of said sensing electrode that is exposed to the ambient atmosphere has a surface area smaller than the surface area of the surface of the counter electrode that is exposed to said water vapor, whereby the first protonic conductive electrolyte membrane is exposed to substantially 100 percent relative humidity, and a positive pressure of said water vapor exists from the surface of said counter electrode that is exposed to said water vapor to the surface of said sensing electrode that is exposed to the ambient atmosphere.

Claim 116. (New) The electrochemical gas sensor as defined in claim 115, wherein the surface area of the surface of the counter electrode that is exposed to said water vapor is separated from said means for exposing a surface of said counter electrode to said water vapor by a hydrophobic membrane permeable to water vapor and substantially impervious to water.

Claim 117. (New) The electrochemical gas sensor as defined in claim 112, wherein at least one of the surfaces of said protonic conductive electrolyte membrane in contact with one of the sensing, counter, and reference electrodes is substantially nonplanar.

Claim 118. (New) The electrochemical gas sensor as defined in claim 112, wherein at least one of the sensing, counter, and reference electrodes is comprised of film having a thickness in the range of about 50 Angstroms to 10,000 Angstroms.

Claim 119. (New) The electrochemical gas sensor as defined in claim 118, wherein the film is substantially composed of a noble metal.

Claim 120. (New) The electrochemical gas sensor as defined in claim 119, wherein the noble metal is platinum.

Claim 121. (New) The electrochemical gas sensor as defined in claim 112, wherein the protonic conductive electrolyte membrane is substantially comprised of a solid, perfluorinated, ion-exchange polymer.

Claim 122. (New) The electrochemical gas sensor as defined in claim 112, wherein the protonic conductive electrolyte membrane is a hydrated metal oxide protonic conductor electrolyte membrane.

Claim 123. (New) The electrochemical gas sensor as defined in claim 112, wherein the proton conductor material for said at least one of the sensing, counter, and reference electrodes is a copolymer having a tetrafluoroethylene backbone with a side chain of perfluorinated monomers containing at least one of a sulfonic acid group or a carboxylic acid group.

Claim 124. (New) The electrochemical gas sensor as defined in claim 112, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of platinum.

Claim 125. (New) The electrochemical gas sensor as defined in claim 112, wherein one of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 50-99 wt % of carbon black, and the other of the first and second electrical conductor materials for said at least one of the sensing, counter, and reference electrodes is about 1-50 wt % of Ru oxide.

Claim 126. (New) A residential electrochemical gas sensor for quantitative measurement of carbon monoxide gas in an ambient atmosphere comprising:

a sensing electrode permeable to water vapor and comprised of an electrical conducting material and having a surface exposed to the ambient atmosphere;

a counter electrode permeable to water vapor and comprised of an electrical conducting material;

a first protonic conductive electrolyte membrane permeable to water vapor and situated between and in contact with the sensing and counter electrodes, the sensing electrode being capable of reacting with the carbon monoxide gas to produce a change in electrical characteristic between the sensing electrode and the counter electrode;

means for electrical measurement electrically connected to said sensing and counter electrodes;

means, containing a volume of water vapor, for exposing a surface of said counter electrode to said water vapor, wherein the electrical conducting material of at least one of said sensing and counter electrodes is a proton-electron mixed conductive material having 10-50 wt % of a proton conductor material and 50-90 wt % of a first and a second electrical conductor material;

whereby, in a positive ambient atmosphere concentration of the carbon monoxide gas at room temperature, said electrical measurement means is capable of detecting changes in said electrical characteristic.

Claim 127. (New) The electrochemical gas sensor of claim 126 in which the sensing electrode comprises a mixed protonic-electronic conductive electrode.

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